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When “It” Becomes “Mine”: Attentional Biases Triggered by Object Ownership

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Abstract

■ Previous research has demonstrated that higher-order cognitive processes associated with the allocation of selective attention are engaged when highly familiar self-relevant items are encountered, such as one’s name, face, personal possessions and the like. The goal of our study was to determine whether these effects on attentional processing are triggered on-line at the moment self-relevance is established. In a pair of experiments, we recorded ERPs as participants viewed common objects (e.g., apple, socks, and ketchup) in the context of an “ownership” paradigm, where the presentation of each object was followed by a cue indicating whether the object nominally

belonged either to the participant (a “self” cue) or the experimenter (an “other” cue). In Experiment 1, we found that “self” ownership cues were associated with increased attentional processing, as measured via the P300 component. In Experiment 2, we replicated this effect while demonstrating that at a visual-perceptual level, spatial attention became more narrowly focused on objects owned by self, as measured via the lateral occipital P1 ERP component. Taken together, our findings indicate that self-relevant attention effects are triggered by the act of taking ownership of objects associated with both perceptual and postperceptual processing in cortex. ■

INTRODUCTION

Taking ownership of objects is a ubiquitous experience in everyday life. Whether we are purchasing a new pair of shoes or simply grabbing something to eat, we are constantly changing our psychological relationship with objects by the act of taking personal possession. It is thus somewhat surprising that little is known about the cognitive underpinnings of subsuming ownership—in essence, what happens when *a* pair of Nikes or *a* banana becomes *my* pair of Nikes or *my* banana? Here we examine this issue from the perspective of self-relevant information processing, and in particular, we ask whether attentional effects associated with self-relevant stimuli are triggered or initiated at the moment we take ownership of an object.

In this regard, it has long been appreciated that we parse or sort incoming information from the external environment on the basis of current goal states, past experience, or personal values—that is, on the basis of its relevance to self (e.g., Conway & Dewhurst, 1995; Postman, Bruner, & McGinnies, 1948). For example, in dichotic listening studies that present different messages to each ear but require attention to only one channel, information presented to the unattended ear is more likely to penetrate conscious awareness when it contains self-relevant information (e.g., the participant’s name or words consistent

with the participant’s self-concept), relative to similar material not related to self (e.g., Bargh, 1982; Moray, 1959). Likewise, Tong and Nakayama (1999) showed that participants were faster to detect the presence of their own face among a set of distracter faces than they were to detect the presence of a familiar face. At the same time, the processing benefits afforded to self-relevant information is not limited to the perceptual domain, as memory for task materials is also greater for items related to the self (Van den Bos, Cunningham, Conway, & Turk, 2010; Cunningham, Turk, Macdonald, & Macrae, 2008; Turk, Cunningham, & Macrae, 2008; Symons & Johnson, 1997; Rogers, Kuiper, & Kirker, 1977). Such evidence has suggested that not only do we pay greater attention to self-relevant information, but that we do this automatically (e.g., Bargh & Pratto, 1986; Bargh, 1982; Moray, 1959; Cherry, 1953).

In a direct test of this hypothesis, Gray and colleagues recently asked participants to view words on a computer screen while they recorded the participants’ brain electrical responses via ERPs (Gray, Ambady, Lowenthal, & Deldin, 2004). The words themselves were things like names and places and came from two different categories presented with equal probability: words directly relevant to the participant (e.g., the participant’s name and hometown) and words not directly relevant to the participant. What they found in the ERP data was that, whereas self-relevant words generated a P300 component, words from the non-self-relevant category did not. Given that P300s can be generated to stimuli with personal “emotional value” regardless

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of their contextual probability and task relevance (e.g., Johnston, Miller, & Burleson, 2004), Gray et al. (2004) concluded that we do in fact devote greater attentional resources to self-relevant information (see also Ninomiya, Onitsuka, Chen, Sato, & Tashiro, 1998; Berlad & Pratt, 1995; Fischler, Jin, Boaz, Perry, & Childers, 1987).

In light of the findings by Gray et al. (2004), the goal of the current study was to determine whether this enhanced attentional processing of self-relevant stimuli is initiated by the act of taking ownership of an object. In essence, when something becomes ours, does this alter how we attend to it? The question is of importance because, unlike things such as our name and hometown (e.g., Gray et al., 2004) or objects we already own (e.g., Miyakoshi, Nomura, & Ohira, 2007), it remains unclear whether the attentional benefits afforded to self-relevant items can be dynamically ascribed in real-time to arbitrary objects with which we have no prior personal history.

To address this issue, we utilized a modified version of the “shopping” paradigm employed by Cunningham et al. (2008). On a computer screen, participants viewed highly familiar items found in major supermarkets (e.g., fruit and toiletries) one at a time, each presented centrally and with a square black border around the object image. Shortly after the presentation of the item, the border around the object changed in color to either red or blue. The color change served as a cue to object ownership, such that one color signaled the object was now the participant’s, whereas the other color signaled that the object was now the experimenter’s. The mapping of color to ownership condition (“self” vs. “other”) was counterbalanced between participants and an equal number of objects were assigned to the two ownership conditions. Following the ownership cue, the participants’ task was to simply indicate with a manual two-choice response whether the given object was his or hers versus the experimenters’.

Our primary dependent measure was the P300 elicited by the ownership cue, as a function of whether the cue was for “self” versus “other.” Specifically, we expected a P300 to be generated in both cue conditions, because the cues were targets requiring responses (e.g., Donchin & Coles, 1988). However, if the attentional benefits of self-relevant processing are in fact triggered at the moment when ownership of an object is taken, then it is predicted that the P300 elicited by “self” cues should be larger in amplitude, relative to the P300 elicited by “other” cues.

EXPERIMENT 1

Method

Participants

Fifteen healthy undergraduate students (10 women, mean age = 20 years 1 month) participated in this study for course credit. All had normal or corrected-to-normal vision and no reported neurological abnormalities. All testing

procedures were approved by the University of Aberdeen Psychology Ethics Committee.

Stimuli

The stimulus set comprised a total of 144 digital images of items sold in major supermarkets, generated from internet search engines (e.g., apple, socks, and camera). These images were divided into two equal sets matched on category membership (e.g., fruit, clothing, and electrical items) and on name length. The images were edited so that each item was placed on a white background and resized to 250 × 250 pixels at a resolution of 72 dpi. A border 25 pixels wide was then drawn around the image giving a total display size of 300 × 300 pixels. This border was generated in three color hues (black, red, and blue). During the experiment, the same image was presented twice within each trial, once with a black border and a second time with a colored border. This border color was used to denote item ownership. Stimuli were presented on a VGA monitor controlled by a Pentium PC using presentation software (Neurobehavioral Systems, Albany, CA).

Procedure

Participants were seated 57 cm from the computer screen. Each study began with the onscreen presentation of an image of a red and a blue basket in the top right and top left corner of the screen. These remained on the screen throughout the experiment. Participants were instructed that they were undertaking a sorting task, and that they were to place items into the correct basket denoted by the border color using a button press. Response buttons were spatially aligned with the presented basket images so that pressing a button on the left would indicate placing the item in the blue (left) basket. Participants were also informed that they owned the contents of one of their basket and that the experimenter owned the contents of the other basket. The assignment of baskets and items to owners was counterbalanced across participants in this study. Previous research has shown that basket location or color assignment had no effect on cognitive processing in an ownership task (Cunningham et al., 2008). Given this finding and our counterbalanced procedure, any differences in ERPs to targets should be because of task-related processes (i.e., ownership) rather than stimulus properties (i.e., location of basket, color of basket, or object effects).

During this sorting phase, participants were presented with an image of an item found in most major supermarkets (e.g., a pair of socks). This was presented in the center of the computer screen for a variable interval between 400 and 600 msec. The same image was then presented with a colored border for a variable interval between 800 and 1400 msec (giving the appearance of a border change) during which the behavioral response was made. A variable inter-trial interval of between 2400 and 2600 msec during which only the basket images were presented then followed.

All events of interest were presented in one continuous recording sequence.

Electrophysiological Recording

Scalp potentials were recorded from 64 Ag–AgCl active electrodes via a Biosemi Active Two ERP system. Continuous EEG was sampled at 512 Hz. Vertical and horizontal eye movements were recorded using four additional electrodes placed on the outer canthus of each eye and one above and one below the right eye. Two additional electrodes were used to record from the left and right mastoids. All recorded voltages were made relative to a common mode voltage based on the Active Two's CMS/DRL feedback loop. EEG analysis was performed using EEGLAB (Delorme & Makeig, 2004; www.sccn.ucsd.edu/eeglab) running under Matlab 7.7 (The Mathworks, Cambridge, MA). Off-line, all scalp electrodes were referenced to the average of the left and right mastoid signals and filtered with a bandpass of 0.1–30 Hz. Automated artifact rejection was then used to eliminate trials with detectable eye movements, blinks, muscle potentials or amplifier blocking. The criteria used to reject a segment included a change between adjacent sampling points of $\pm 20 \mu\text{V}$ and a change of more than $150 \mu\text{V}$ across the entire segment. Across participants, no more than approximately 10% of trials were rejected on the basis of these artifacts. For each participant, EEG time-locked to the remaining events of interest was epoched into 700-msec segments, beginning 200 msec before stimulus onset until 500 msec post-stimulus. These epochs were then signal-averaged within each condition, digitally low-pass filtered (25.6 Hz half-amplitude cutoff) and baseline corrected to remove any linear slow-wave drifts. These single-subject waveforms were then used to generate the group-averaged waveforms for display and analysis. A -200 to 0 msec prestimulus baseline was used for all ERP waveform measurements and displays.

Results

Behavior

Because of some technical issues, response data were absent for 4 of the 15 participants. Analysis of response accuracy during the sorting phase showed that the remaining 11 subjects made small numbers of errors (self, 2.7%; other, 2.8%) in each of the encoding conditions.

We also examined response latency in these same 11 participants during the sorting phase. Median RTs (self, 442 msec; other, 449 msec) did not differ across ownership conditions [$t(10) = -0.509, p > .6$].

ERPs

The P300 ERP component can be seen in Figure 1 as a function of cue condition. To identify whether the P300

amplitude varied between cue conditions, we conducted an omnibus repeated measures ANOVA that included a factor of Cue Condition (self vs. other). Consistent with the findings of Gray et al. (2004) and the P300 in general (e.g., Donchin & Coles, 1988), the P300 was maximal over the midline central and parietal electrode sites; our ANOVA thus also included nine total electrodes via factors of Scalp Electrode Scalp Location (C1/CZ/C2 vs. CP1/CPZ/CP2 vs. P1/PZ/P2) and Hemisphere of Electrode (left vs. midline vs. right). As reported in Table 1, mean amplitude measures were taken at each electrode over a 100-msec time window centered on the approximate P300 peak in the grand averaged waveforms (310–410 msec post-stimulus). We found a significant main effect of Cue Condition [$F(1, 14) = 6.18, p < .05$, partial $\eta^2 = 0.306$], such that the P300 amplitude was larger for self versus other cues (means: self, $10.51 \mu\text{V}$; other, $9.18 \mu\text{V}$). This effect of Cue Condition did not interact with Scalp Location [$F(2, 13) = 1.69, p > .22$] or with Hemisphere of Electrode [$F(2, 13) = 0.86, p > .44$].

Discussion

Our findings thus indicate that the P300 elicited by the ownership cues was larger for “self” versus “other” cues. This suggests that the attentional benefits afforded to self-relevant stimuli as measured via the P300 (e.g., Miyakoshi et al., 2007; Gray et al., 2004) can be triggered on-line and at the moment ownership of an object is taken. Moreover, it would appear that these effects could be ascribed to objects that we have no specific personal history with. Rather, the mere act of taking ownership of an object seems to be sufficient for activating self-relevant information processing.

Given this preliminary conclusion, we thus wanted to conduct a second experiment with two specific goals. First, could we replicate our finding from Experiment 1? If so, this would provide strong evidence that our initial results were in fact valid and reliable. Although the data from Experiment 1 aligns with the findings of Gray et al. (2004) that self-relevant information processing can bias higher-level, postperceptual aspects of attention-related processes, what about more perceptual or sensory-based aspects of attention? The second goal of Experiment 2 was, therefore, to explore whether taking ownership of an object could affect how we attend to it at a visual-perceptual level as well.

EXPERIMENT 2

Visual attention has a remarkable capacity for modulating the intensity of stimulus-evoked activity in visual cortex. For example, when we increase the amount of attention we pay to an object we're looking at, there are concomitant decreases in the intensity of sensory-evoked activity for stimuli presented in our visual periphery as measured

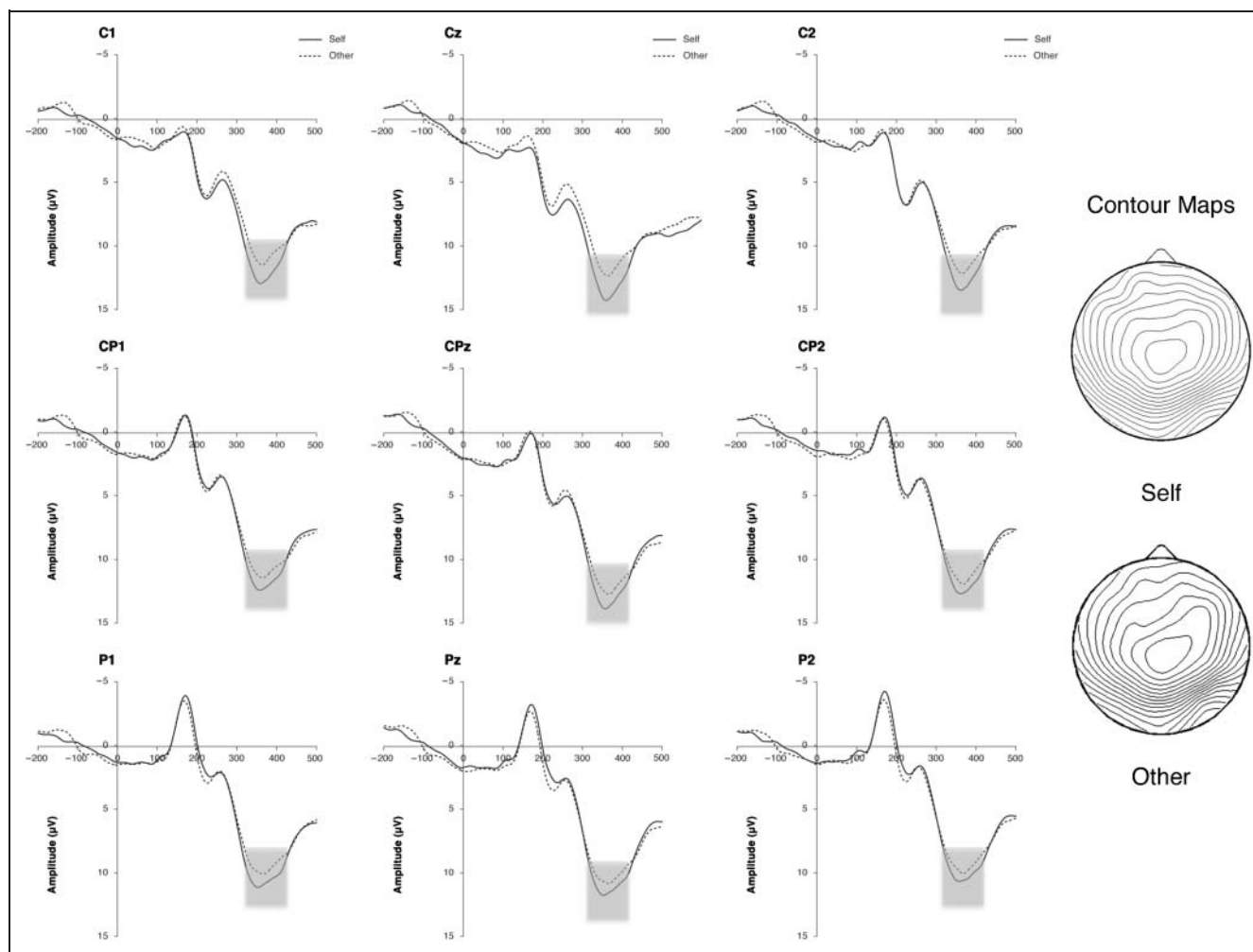


Figure 1. ERP responses to ownership cues, Experiment 1.

via the occipital P1 ERP component (e.g., Handy, Soltani, & Mangun, 2001). These effects of attention on visual processing occur in retinotopically mapped regions of visual cortex (e.g., Woldorff et al., 1997; Heinze et al.,

1994) and reflect attentional consequences for information processing that are distinct from those captured in the P300 (e.g., Donchin & Coles, 1988; Coles & Rugg, 1995). The goal of Experiment 2 was, thus, to replicate our findings from Experiment 1 while determining whether the act of taking ownership of an object can affect attention at the visual perceptual level as well.

Accordingly, we adapted our paradigm from Experiment 1 to include a small task-irrelevant visual “probe” (or square-wave grating) that was briefly presented twice during each trial sequence several degrees of visual angle above the shopping object, centered on the vertical meridian (1) after the onset of the shopping object but before the ownership cue and (2) following the ownership cue. We could then compare the amplitude of the occipital P1 ERP component elicited by this probe, as a function of pre- versus postownership cue and whether the cue was for self versus other. If cues to ownership trigger a greater allocation of visual-perceptual attention to objects we are given (vs. objects given to someone else), the P1 elicited by this visual probe should be reduced specifically when following a self cue.

Table 1. Experiment 1: Mean Amplitudes (µV) and in P300 Time Frame at Selected Electrode Sites

Electrode	Self	SE	Other	SE
C1	10.85	0.73	9.27	0.82
C2	11.24	0.88	9.91	0.77
Cz	12.02	0.77	10.07	0.78
CP1	10.51	0.74	9.30	0.79
CP2	10.71	0.90	9.54	0.73
CPz	11.69	0.76	10.46	0.74
P1	9.44	0.76	8.07	0.75
P2	9.05	0.80	8.01	0.73
Pz	10.17	0.78	8.94	0.80

Methods

Participants

Twenty-four healthy undergraduate students (20 women, mean age = 20 years 3 months) participated in this study for course credit. All had normal or corrected-to-normal vision and no reported neurological abnormalities. All testing procedures were approved by the University of Aberdeen Psychology Ethics Committee.

Stimuli

All stimuli were identical to Experiment 1, with the following exceptions. First, the colored baskets were no longer presented. Second, the image set was reduced to 140 items. Third, square wave gratings were generated in which alternating vertical bands of black and white of equal width were presented in a 50×50 pixel space. These were presented along the vertical meridian in parafoveal perceptual space.

Procedure

The instructions for this experiment were identical to those for Experiment 1, with the exception that participants were instructed to ignore the presence of task-irrelevant gratings presented during the encoding phase. In addition, there were subtle differences in the presentation parameters utilized during this phase of the study to accommodate the presentation of these gratings. As in Experiment 1, participants were presented with an image of an item found in most major supermarkets (e.g., a pair of socks). This was presented in the center of the computer screen for a variable interval between 400 and 600 msec. Following this, the first parafoveal grating was presented along the vertical meridian for 100 msec before the initial image was re-presented for another period of between 400 and 600 msec. The same image was then presented with a colored border denoting item ownership for a variable interval between 800 and 1200 msec (giving the appearance of a border change), during which the behavioral response was made. A second grating was presented between 400 and 600 msec after the onset of this border change, again for a period of 100 msec. A variable inter-trial interval of between 2400 and 2600 msec during which a blank screen was presented and then followed. All events of interest were presented in one continuous recording sequence. The presentation of peripheral gratings before and after the presentation of ownership cues therefore allowed us to measure electrophysiological responses pre- and postownership.

Electrophysiological Recording

All recording and ERP analysis parameters were identical to Experiment 1. Analysis was carried out using Brain Vision Analyzer 2 software.

Results

Analysis of response accuracy during the sorting phase showed that the subjects made small but equal numbers of errors (self, 0.7%; other, 1.13%) across each of the encoding conditions.

We also examined response latency during the sorting phase. Median RTs (self, 496 msec; other, 518 msec) were significantly different across the two ownership conditions [$t(23) = -2.609, p < .05$], with shorter latency.

ERPs: P3

The P300 ERP component can be seen in Figure 2 as a function of cue condition. To identify whether the P300 amplitude varied between cue conditions, we conducted an omnibus repeated measures ANOVA that included a factor of Cue Condition (self vs. other). We included six electrodes via factors of scalp electrode Scalp Location (CP1/CPZ/CP2 vs. P1/PZ/P2) and Hemisphere of Electrode (left vs. midline vs. right). As reported in Table 2, mean amplitude measures were taken at each electrode over a 20-msec time window centered on the approximate P300 peak in the grand averaged waveforms (373–393 msec poststimulus). We found a significant main effect of Cue Condition [$F(1, 23) = 8.28, p < .01$, partial $\eta^2 = 0.265$], such that the P300 amplitude was larger for self versus other cues (means: self, 4.81 μV ; other, 3.73 μV). This effect of Cue Condition did not interact with Scalp Location [$F(1, 23) = 3.61, p > .05$] or with Hemisphere of Electrode [$F(2, 22) = 0.73, p > .49$].

ERPs: P1

The P1 ERP component can be seen in Figure 3 as a function of cue condition. To identify whether the P1 amplitude varied between cue conditions, we conducted an omnibus repeated measures ANOVA that included a factor of Cue Condition (self vs. other vs. pre-owned). Consistent with the literature, P1 was maximal over occipital electrode sites (Mangun & Hillyard, 1991, 1995); our ANOVA, thus, also included three total electrodes via Hemisphere of Electrode (left vs. midline vs. right). As reported in Table 3, mean amplitude measures were taken at each electrode over a 10-msec time window centered on the approximate P1 peak in the grand averaged waveforms (125–135 msec poststimulus). We found a significant main effect of Cue Condition [$F(2, 22) = 5.57, p < .05$, partial $\eta^2 = 0.336$]. Subsequent means comparisons (least significant difference) on the main effect of Cue Condition demonstrated that there was a significant decrease in P1 on self cue trials relative to the pre-owned condition ($p < .01$) and that P1 amplitude for self-cued trials was significantly lower than for other cued trials ($p < .05$). However, there was no significant decrease in P1 for other cue trials relative to pre-owned responses ($p = .26$). This main effect

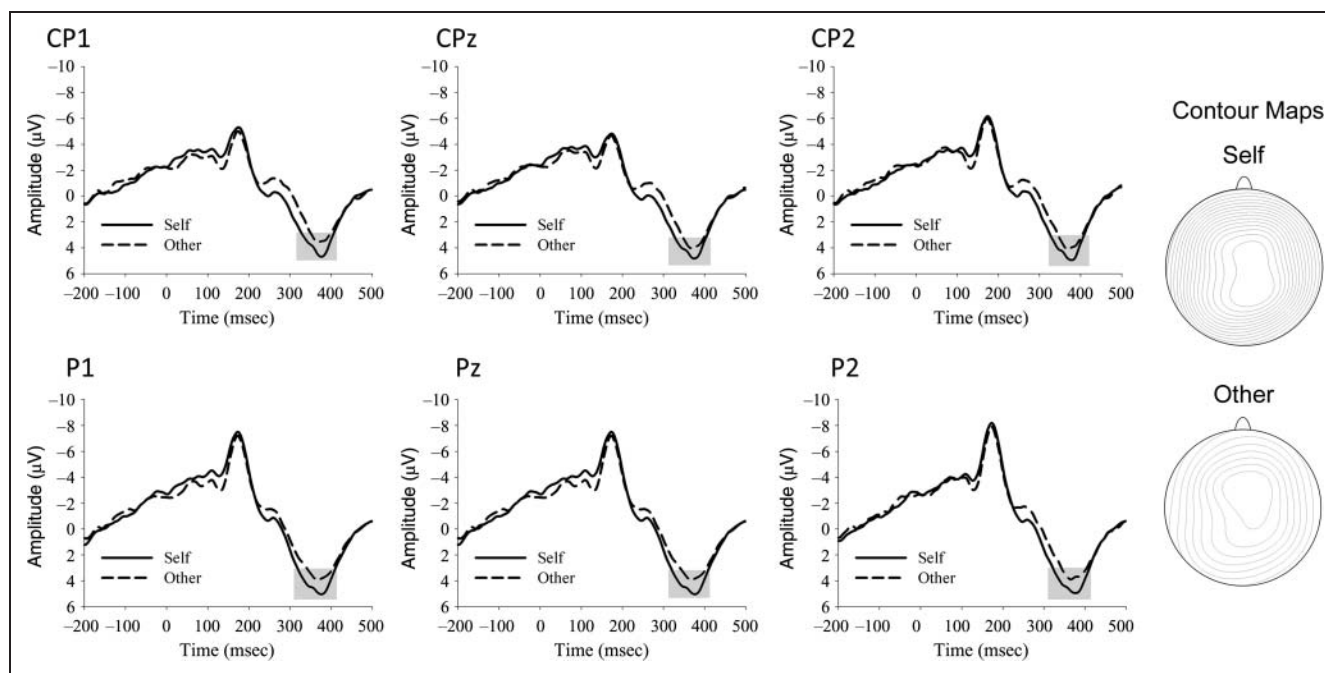


Figure 2. ERP responses to ownership cues, Experiment 2.

of Cue Condition did not interact with Hemisphere of Electrode [$F(4, 20) = 0.76, p > .56$].

Discussion

Experiment 2 was carried out in an attempt to replicate the P300 effects observed in Experiment 1 and to explore the impact on the detection of self-relevance on visual attention to the owned object. As for the previous study, we observed significant differences in the P300 component as a function of ownership at centro-parietal and parietal midline electrode sites. This finding is in line with previous ERP experiments exploring self-relevance (Miyakoshi et al., 2007; Ninomiya et al., 1998; Berlad & Pratt, 1995; Fischler et al., 1987).

In addition, we also observed changes in the visual attention directed toward self-relevant objects. Our data show significant decreases in the P1 component at occipital electrode sites toward self-owned objects compared

with other-owned objects and in contrast to pre-owned responses. This decrease in the P1 postownership is interpreted as reflecting a narrowing of attention to owned objects, and therefore, a reduction in the P1 capture associated with irrelevant visual gratings presented in the periphery (Handy et al., 2001). In essence, peripherally presented task-irrelevant visual information received greater processing in other-owned events, and this may also explain the significant increase in response latency observed on these trials.

GENERAL DISCUSSION

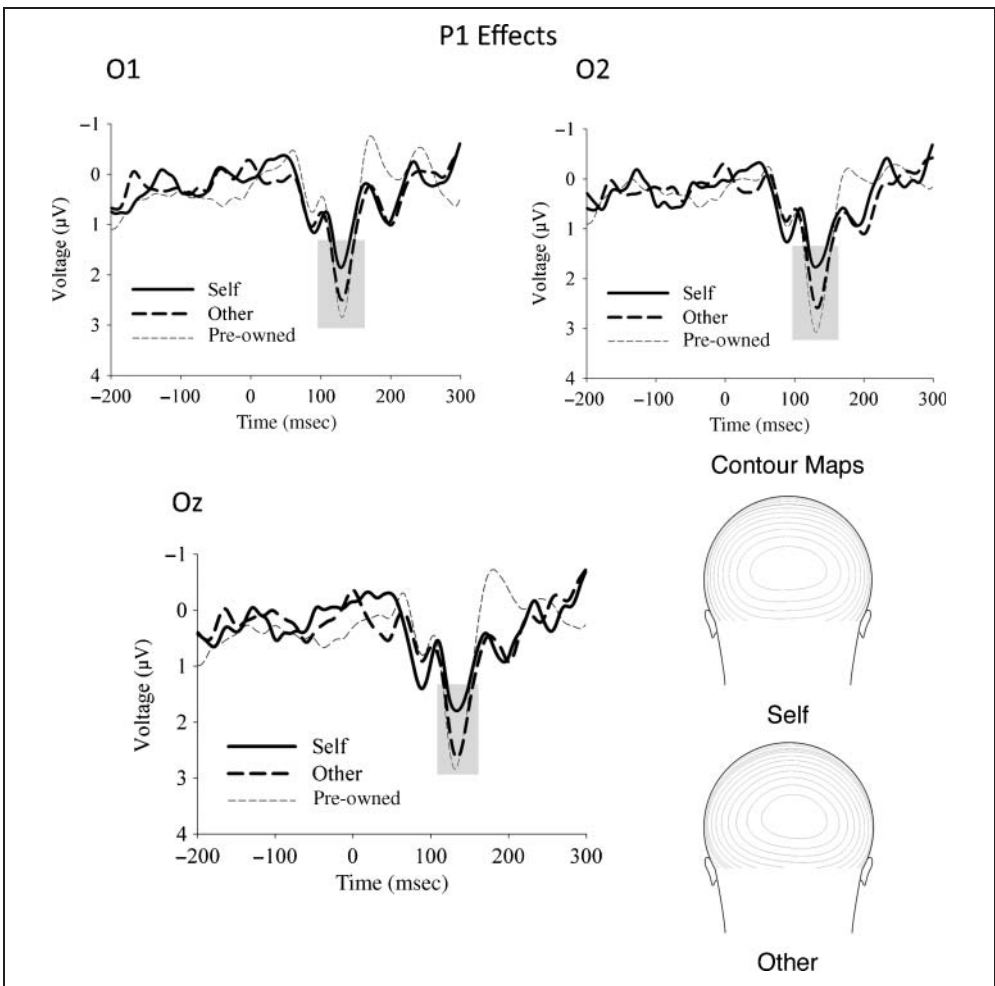
Our study was designed to ask whether attentional effects associated with self-relevant stimuli are triggered when we first take ownership of an object. The experiments themselves followed from prior work demonstrating that self-relevant information, such as your name or the name of your hometown, generate a greater degree of cognitive analysis as measured via a P300 ERP response, relative to information lacking in direct self-relevance (e.g., Miyakoshi et al., 2007; Gray et al., 2004). In this regard, we had two key findings. First, in Experiment 1, we found that “self” ownership cues generated significantly larger P300s in comparison with “other” ownership cues. Second, in Experiment 2, we replicated this P300 effect while demonstrating that, at a perceptual level, visual attention also becomes more narrowly focused on objects we own—an effect that emerges within a few hundred milliseconds of taking object ownership.

The fact that “self” ownership cues in our paradigm generated a larger P300 response relative to “other” cues has several important implications. For one, given that

Table 2. Experiment 2: Mean Amplitudes (µV) in P300 Time Frame at Selected Electrode Sites

Electrode	Self	SE	Other	SE
CP1	4.61	0.57	3.49	0.49
CP2	4.89	0.65	3.99	0.55
CPz	4.74	0.65	3.90	0.54
P1	4.72	0.64	3.49	0.47
P2	4.90	0.64	3.72	0.48
Pz	4.97	0.70	3.80	0.60

Figure 3. ERP responses to peripheral grating stimuli, Experiment 2.



P300s are generated to stimuli with personal “emotional value” regardless of contextual probability and task relevance (e.g., Johnston et al., 2004), it suggests that the attentional benefits we naturally afford to self-relevant items can be dynamically ascribed in real-time to objects at the moment we take ownership. For another, that these effects were found for arbitrary objects that participants had had no prior personal experience with indicates that the cognitive processing benefits associated with self-relevant information or stimuli do not depend on familiarity with the given item or object. Rather, as any parent of young children well knows, as soon as something is considered “mine,” that appears to be sufficient to alter our cognitive relationship to that object.

Table 3. Experiment 2: Mean Amplitudes (µV) in P1 Time Frame at Selected Electrode Sites

Electrode	Self	SE	Other	SE	Not Owned	SE
O1	1.83	0.43	2.45	0.41	2.77	0.42
O2	1.75	0.49	2.47	0.41	3.00	0.42
Oz	1.74	0.51	2.47	0.42	2.75	0.53

Notably, however, the attentional effects of taking object ownership were not limited to the cognitive level. In Experiment 2, when we examined the sensory-evoked responses in visual cortex to task-irrelevant probes presented in the visual periphery both before and after ownership cues were given, the intensity of these responses was specifically reduced for probes presented following a “self” ownership cue. What does this suggest? When the perceptual load of a task at fixation is increased, there is a reduction in the amplitude of the lateral occipital P1 component elicited by task-irrelevant probes in the visual periphery, an effect taken as ipso facto evidence that visual spatial attention has narrowed about fixation under high-load conditions (e.g., Handy et al., 2001). Our P1 data from Experiment 2 thus suggest that a similar perceptual-level effect arises when we take ownership of an object—when something becomes ours, not only do we afford it a greater degree of cognitive processing but our visual attention appears to automatically zoom in on that object as well.

In light of these conclusions, it is also important to highlight several control issues. For example, because the materials employed in our study consisted of highly familiar, common objects, it is unlikely that the reported P300

effects are related to systematic differences in item familiarity between conditions of interest. Nor are the effects likely to be because of any inherent differences in the physical or low-level image properties of the stimuli themselves, as the assignment of objects to “self” versus “other” conditions was counterbalanced across participants. Instead, it appears that the differences in the P300 for “self” versus “other” conditions was likely driven by the actual encoding of cue self-relevance.

Likewise, one might argue that the reduction in P1 amplitude for the visual probes following “self” cues could reflect cue-dependent shifts in more general attentional states rather than a specific narrowing of visual spatial attention. For instance, when we naturally drift into a mind wandering state, where one’s thoughts become more internally focused, there is a concomitant reduction in the degree of sensory processing in both the visual and auditory domains (Kam et al., 2011)—effects directly analogous to what we observed in our P1 data. Accordingly, if “self” cues triggered a greater degree of internal reflection relative to “other” cues, then that could explain our P1 results from Experiment 2. Critically, however, mind wandering is also associated with decreased P300 responses to external stimuli (e.g., Smallwood, Beach, Schooler, & Handy, 2008), the opposite P300 pattern to what we observed here for “self” cues.

In closing, self-relevant information processing has been argued to impact upon other cognitive and behavioral processes such as recognition memory (Van den Bos et al., 2010; Cunningham et al., 2008; Turk et al., 2008). It would also be interesting to explore the extent to which the identified cognitive and perceptual attention effects we observed here might predict the magnitude of the self-memory bias associated with object ownership (Van den Bos et al., 2010; Cunningham et al., 2008). Specifically, is the self-memory advantage observed in object ownership related to the magnitude of the degree of self-relevant information processing (as measured via the P300), the narrowing of visual-perceptual attentional focus (as measured via the P1), or both? Given the ubiquity of object ownership in everyday life, future studies might profitably explore these central, self-relevant issues.

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